BHARATI VIDYAPEETH UNIVERSITY,
Pune.

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COURSE STRUCTURE & SYLLABUS

M. Tech. (Electrical) (Semester - I to IV)

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BHARATI VIDYAPEETH UNIVERSITY, PUNE

M. Tech. (ELECTRICAL) (Sem. I to IV)

HIGHLIGHTS

Bharati Vidyapeeth University College of Engineering (BVUCOE) is the largest Engineering College in Maharashtra with an intake of 700 students in each academic year. Imparting quality technical education from Under Graduate to Doctorate Level, BVUCOE is probably the only Engineering College in India with an accreditation from both NAAC as well as NBA. The faculty at BVUCOE boasts of highly qualified academicians, a quality that is further emphasized by the fact that 15 of them are presently pursuing their Ph.D. degree.

BVUCOE has been ranked 29th amongst the Top 50 Technical Schools of India in survey conducted by DATAQUEST-IDC. We have enjoyed a ranking in this list for the last 4 years. Research is of utmost importance in all our programs. A total of 113 research papers were published in the academic year 2007-2008.

Currently we have 12 ongoing research projects. The infrastructure of BVUCOE is state-of-the-art with 62 classrooms, 59 laboratories and a well-stocked library that currently holds 27,130 titles. The college has an international presence with MoUs signed with the North Carolina A&T State University (Greensboro, USA), University of Venice (Italy), Actel Corporation (USA).Corporate interaction is also inculcated in our programs through our association with Oracle India Ltd., Infosys Ltd. and Tata Consultancy Services.

DEPARTMENT OF ELECTRICAL ENGINEERING

Electrical Branch and the Electrical Engineering Department was established in the year 1987 with the permission of AICTE New Delhi with an intake capacity of 60 students. The college and the course were affiliated to the University of Pune. The University Grants Commission and the Ministry of Human Resource Development, Govt. of India awarded the Deemed University status to the Institution and the Department in the year 2000.

The specious infrastructure, well equipped laboratories, meritorious students and academically qualified and enthusiastic faculty being the salient features of the Department. Electrical Department runs U.G., P.G. & Ph.D. courses and imparts education of very high standard and has created its own impression in the society. The students are admitted to B.E. & M.E. course through Common Entrance Examination conducted on All India Basis.

More than 900 students have acquired B.E. (Electrical) degree and most of them have attained high positions in the organizations of repute. Some students continued their studies abroad and some have their own business. This shows the versatility of the knowledge they acquired in the department.

The department, apart from routine academic Curriculum takes keen interest in several other academic activities like conducting seminars, workshops, conferences, expert lectures etc. and updates the practical aspects through industry -institute interaction. The department maintains good culture and discipline by having close association with each student through 'Teacher Guardian Scheme'. One of the main achievements of the department is that in last 3 years BE Electrical students were placed 100 % in top ranking companies in India and abroad.

The department is well equipped with following Laboratories:

Electrical Machines Labs [A &B], Electrical Measurements and Instrumentation Lab, Switch gear protection and H V Lab, Network Analysis and Microprocessor Lab, Industrial Drives and Control and Basic Electrical Lab, Computer and Software Center / Lab, Power System Lab, Control System Lab

DEPARTMENTAL LIBRARY

The Departmental Library, organized by ASEE, is having good number of titles of Text Books, Reference books. Technical Journals U G and P G Seminar and Dissertation Reports, Audio Video CDs on Technical Topics.

MAJOR GROUPS/AREAS IN THE DEPARTMENT

Electrical Power System, SCADA and Automation, Computer Applications in Power Systems, Electrical Control Systems, Electrical Machines, Electrical Drives and Control, Electrical Measurements, High Voltage Engineering, Microprocessors and controllers

EXPERTISE IN RESEARCH AND CONSULTANCY

The department is actively engaged in number of research projects, which are sponsored, by A.I.C.T.E., U.G.C. & other funding agencies.

MAJOR EQUIPMENTS

Synchronous Induction Motor, Linear Induction Motor, Microprocessor Kits, Relay Testing Kit, HV transformer with Sphere gap arrangement, Alternator Protection scheme, Switchgear Testing Kits, Clamp on Power Meter, 5 stage HV impulse generator.

SOFTWARES

PSCAD, ETAP, Electro-2D/3D, Magneto-2D/3D, ORSTEAD, MATLAB, All other Licensed Windows, Antivirus [Quick Heal]

Students Placements:

Recruitment of the Electrical students through Campus Interview

The students are selected in various Companies Like TCS, CTS, Infosys, Wipro, Kanbay, Accenture, Tech Mahindra , HSBC,ICICI Bank ABB, AREVA T&D, Siemens, Rockwell Automation, JSW, L&T, CG, NDPL, Tata Power, Bhatiya Group of Companies-Power Machines Ltd. Dubai, US Technology & many more.

- In 2004-05 Placement of the Electrical students was 100 % [57 Out of all 57 Eligible students]
- In 2005-06 Placement of the Electrical students is 100 % [58 Out of 58 Eligible Students].
- In 2006-07 Placement of the Electrical students is 100 % [60 Out of 60 Eligible Students].

STRUCTURE & EXAMINATION PATTERN

M. Tech. - Electrical Engineering

Semester I

Total Duration : 30 Hrs/Week
Total Marks : 500

Subject Code	Subject	Teaching Scheme (Hrs.)			Examination Scheme (Marks)				Total (Marks)
		L	T	P	Theory	Unit Test	T.W.	Oral	
K40501	Optimization Techniques	04	-	-	70	30	-	–	100
K40502	High Voltage Power Transmission	04	-	-	70	30	-	-	100
K40503	Microcontroller & their Applications	04	-	02	70	30	25	25	150
K40504	Power System Modelling	04	-	02	70	30	25	25	150
	Total	16	-	04	280	120	50	50	500

SemesterII

Total Duration : 30 Hrs/Week
Total Marks : 500

Subject Code	Subject	Teaching Scheme (Hrs) Hrs/Week			Examination Scheme (Marks)				Total (Marks)
		L	T	P	Theory	Unit Test	TW.	Oral	
K40505	Power System Dynamics	04	-	-	70	30	-	-	100
K40506	Advanced Protective Relaying	04	-	02	70	30	25	25	150
K40507	Power System Automation and Control	04	-	02	70	30	25	25	150
K40508	Power System planning & Reliability	04	-	-	70	30	-	-	100
	Total	16	-	04	280	120	50	50	500

Year I (semester I+II) Total marks = 1000

M. Tech. - Electrical Engineering (Power System)

Semester III

Subject Code	Subject	Teaching Scheme (Hrs.)		Examination Scheme (Marks)				Total (Marks)
		L	P	Theory	Unit Test	TW	Oral	
K40509	*Elective I	04	-	70	30	-	-	100
K40510	* # Elective II	04	-	70	30	-	-	100
K40511	Seminar	-	01	-	-	25	50	75
K40512	Dissertation stage I	-	04	-	-	50	50	100
	Total	08	05	140	60	75	100	375

Semester IV

Subject Code	Subject	Teaching Scheme (Hrs.)		Examination Scheme (Marks)				Total (Marks)
		L	P	Theory	Unit Test	TW	Oral	
K40513	Dissertation Stage II	-	04	-	-	150	75	225
	Total	-	04	-	-	150	75	225
Year II (semester III+IV) Total = 600								
Marks Grand Total Year (I+II)=1600								

Elective – I

a. Artificial Intelligence & It's Applications in Power Systems
b. Electrical Power quality issues
c. Advanced Power Electronics
d. Static Devices in Power Systems

Elective II

a. Renewable energy systems
b. Advance Microcontrollers & It's Applications in Power System
c. Power Sector Economics & Restructuring
d. Nano-technology
#e. Any other Subject proposed by the sponsoring industry

*Elective subjects are to be studied by the students under the guidance of their guides.
Any industry sponsored subject can be offered as an elective subject where in the concerned may propose the subject not listed in the list of electives. However such Proposal along with the syllabus shall be forwarded to the university by the concerned Industry well in advance so that the other formalities of the university can be completed prior to the conduct of Term & examinations.

Project:

Stage-I:
The student has to perform the following under stage - I
Identification of problem
Preparation of abstract
Literature survey

Stage-II:
The student has to perform the following under stage II
Experimentation
Observations
Conclusion
Submission of final report

No of students per project group: 01 student

RULES FOR CONDUCTING TESTS

Mode of the test

- Three unit tests per subject shall be conducted in each semester. The schedule for the same will be declared in the academic calendar of each term.
- Each unit test shall carry 30 marks.
- University examination pattern has given weightage of 30 marks for unit tests and 70 marks for theory examination
- To calculate final marks of the unit test following procedure is followed:

  i) Out of the three unit tests conducted during the semester, the marks of only two unit tests in which the candidate has shown his/her best performance shall be considered, to decide the provisional marks in each subject

  ii) Average marks obtained in two unit tests in which students have performed well shall be considered as provisional marks obtained by the student.

  iii) If the candidate appears only for two unit tests conducted during the semester, he/she will not be given the benefit of the best performance in the tests.

  iv) If the candidate appears only for one unit test conducted during the semester, to calculate the marks obtained in the unit tests it will be considered that the candidate has got 0 (zero) marks in other unit tests.

  v) There is separate passing in theory examination. A candidate has to secure minimum 28 marks(i.e.40%) out of 70 marks to declare him/her pass. Provisional marks obtained by the candidate in unit tests should reflect as proportional to the marks obtained in theory examination. In case of disparity of more than 15% it will be scaled down accordingly. These marks will be final marks obtained by the student. No scaling up is permitted.

  vi) Unit test marks will be added in theory examination marks only after passing of candidate in theory examination in respective subject.
- Paper pattern for the unit tests:
- All questions are compulsory with weightage as following:

  Question 1 - 10 marks
  Question 2 - 10 marks
  Question 3 - 10 marks
- For granting the term it is mandatory to appear for all the three unit tests conducted in each semester.
- Roll numbers allotted to the students shall be the examination numbers for the unit tests.

SEMESTER - I

K40501: OPTIMIZATION TECHNIQUE

TEACHING SCHEME
Lectures : 04 Hrs/week

EXAMINATION SCHEME
Theory : 70 Marks
Duration : 03 Hours
Unit Test : 30 Marks

Unit-I (07 Hours)

Classical Optimization Techniques :

Single variable optimization, multivariable optimization with no constraints, multivariable optimization with equity constraints, and multivariable optimization with inequity constraints, Kuhn-Tucker conditions, constraint qualification.

Unit-II (07 Hours)

Optimization:

Linear programming, standard form of L.P.P., formulation of models, simplex methods, Simplex algorithm, revised simplex method duality in L.P., decomposition principle, sensitivity, transportation problems, Karmarkars method.

Unit-III (07 Hours)

Non-Linear Programming - I:

One-dimensional search, Fibonacci and golden section method, golden section method, Quadratic and cubic interpolation methods, direct root methods.

Unit-IV (07 Hours)

Non-Linear Programming – II:

Unconstrained optimization introduction, Direct search methods, Indirect search methods, steepest descent / ascent method.

Unit-V (07 Hours)

Non-Linear Programming – III :

Constrained optimization techniques, Direct methods, Indirect methods- Penalty Function method Augmented Lagrange multiplier method, Test problems.

Unit-VI (07 Hours)

Dynamic Programming:

Multistage decision process and concept of sub optimization, Bellemen's optimality principle, recursive relation – backward and forward recursion, inventory problem, capital budgeting and path finding problem by dynamic programming.

Text Books/ References

- SS Rao, "Engineering Optimization", New Age International
- S.S.Rao, "Optimization-Theory and applications",Wiley Easter Publications
- K.V.Mittal, "Optimization Methods", Wiley Easter Publications
- Gillete, "Computer Oriented Operation Research", Mc-Graw Hill Publications
- Bazara, Sherali Shetty, "Non-Linear Programming Theory and Algorithms", John Wiley and Sons, Inc.
- Bertsekas D. P., "Constrained Optimization and Lagrange Multiplier Methods", Academic Press, New York,1982

Syllabus for Unit Test

Unit Test 1	Units I & II
Unit Test 2	Units III & IV
Unit Test 3	Units V & VI

K40502: HIGH VOLTAGE POWER TRANSMISSION

TEACHING SCHEME
Lectures : 04 Hrs/week

EXAMINATION SCHEME
Theory : 70 Marks
Duration : 03 Hours
Unit Test : 30 Marks

Unit-I (08 Hours)

Engineering Aspects of EHV AC Transmission System:

Principles, configuration, special features of high voltage AC lines, power transfer ability, reactive power compensation, audible noise, corona bundle conductors, electric field, right of way, clearances in a tower, phase to phase, phase to ground, phase to tower, factors to be considered, location of ground wire, angle of protection, clearances, tower configuration. Principles of radio interference, origin of radio interference, method of propagation, factors to be considered in line design.

Unit-II (08 Hours)

Power System Transients

Introduction, circuit closing transients, sudden symmetrical short circuit of alternator, recovery transients due to removal of short circuit, traveling waves on transmission lines, wave equation, surge impedance and wave velocity, specifications of traveling waves, reflection and refraction of waves, typical cases of line terminations , equivalent circuit for traveling wave studies, forked lines, reactive termination, successive reflections, Bewley lattice diagram, attenuation and distortion, arcing grounds, capacitance switching, current chopping, lightning phenomenon, over voltages due to lightning, line design based on direct strokes, protection of systems against surges, statistical aspects of insulation co-ordination.

Unit-III (08 Hours)

Other Issues :

Biological effects of electric field, safe values of electric field, requirements of transmission line, live line maintenance, basic principle, special tools and procedure, methods of voltage control, tap changing, shunt compensation, shunt reactors and shunt capacitors.

Unit-IV (08 Hours)

General Background of High Voltage DC Transmission:

EHV AC versus HVDC Transmission, power flow through HVDC link, equation for HVDC power flow, effect of delay angle and angle of advance, bridge connections, waveform of six pulse and twelve pulse bridge converter, commutation, phase control, angle of extinction, control of DC voltage, connections of three phase six pulse and twelve pulse converter bridges, voltage and current waveforms.

Unit-V (08 Hours)

Bipolar HVDC terminal, converter transformer connections, switching arrangements in DC yard for earth return to metallic return, HVDC switching system, switching arrangements in a bipolar HVDC terminal, sequence of switching operations, HVDC circuit breakers, DC current interruption, commutation principle, probable types and applications of HVDC circuit breakers, multi-terminal HVDC systems, parallel tapping, reversal of power, configurations and types of multi-terminal HVDC systems, commercial multi terminal systems.

Unit-VI (08 Hours)

Faults and abnormal condition in bipolar, two terminal HVDC system, pole-wise segregation, protective zones, clearing of DC line faults and reenergizing, protection .of converters, transformer, converter valves, DC yards, integration of protection and controls, hierarchical levels of control, block diagram, schematic diagram, current control, power control, DC voltage control, commutation channel, master control, station control, lead station, trail station, pole control, equidistant firing control, synchronous HVDC link, asynchronous HVDC Link.

Text Books/References

- Rakosh Das Begamudre, "EHV AC Transmission", New Age Publishers
- Kimbark E.W. , "Direct Current Transmission Vol-I", Wiley Interscience
- Subir Ray, "An Introduction to High Voltage Engineering", Prentice Hall of India Private Limited, New Delhi – 110 001

- Adamson C., Hingorani N. G., "HVDC Transmission"
- DC Uhimann E., "Power Transmission"
- S. Rao, "HVAC and HVDC Transmission, Engineering and Practice" Khanna Publisher, Delhi
- B. M. Weddy and B. J.Cory, "Electric Power Systems", John Wiely and Sons, Fourth edition (2002)
- J.Duncan Glover, Mulukutla S. Sarma, "Power System Analysis and Design", Thomson Brooks/cole / Third Edition (2003)
- B.R. Gupta, "Power System Analysis and Design", S. Chand and Company (2004)

Syllabus for Unit Test

Unit Test 1	Units I & II
Unit Test 2	Units III & IV
Unit Test 3	Units V & VI

K40503: MICROCONTROLLER AND THEIR APPLICATIONS

TEACHING SCHEME
Lectures : 04 Hrs/week
Practicals : 02 Hrs/week

EXAMINATION SCHEME

Theory	: 70 Marks
Duration	: 03 Hours
Unit Test	: 30 Marks
T.W.	: 25 Marks
Oral	: 25 Marks

Unit -I (08 Hours)

Introduction to the concept of micro-controllers. Comparison of microprocessor and microcontroller. Difference between RISC and CISC microcontrollers. Architecture of 8031/51 microcontroller, pin diagram, special function registers. External memory interface with 8051. Operation of I/O ports, counters and timers in 8051.Timer modes.

Unit –II (08 Hours)

Addressing modes, external data moves, code memory read only data moves, Push and Pop, data exchanges, byte level logical operations, bit level logical operations. Rotate and swap operations.

Unit-III (08 Hours)

Serial data I/O, serial data mode interrupt, serial port interrupt, external interrupts, software generated interrupts, interrupt control. Programming of 8051 based on interrupts, serial communication and timers, counters.

Unit-IV (08 Hours)

Instructions affecting flags, Incrementing/decrementing,Arithmetic operations, Jump and call instructions, interrupts and returns.
Members of MCS-51 family.

Unit-V (08 Hours)

Microcontroller development systems. Study of simulators, emulators, assemblers, cross assemblers for micro-controllers, serial interface with PC.
'C' programs for MCS-51 environment. Programs in C for Interrupt handler, serial communication etc.

Unit-VI (08 Hours)

Microcontroller applications. Applications of microcontroller based systems for power systems. Relays like distance relays, over current relay etc. stepper motor interface, speed/position control, control of physical parameters like temperature, pressure. 8051 interfacing to LCD, keyboard, ADC & DAC.

List of Practical

- Programs of addition, subtraction, multiplication etc.
- Programs on logical and decision making group of instructions
- Programs related to interrupt, timer and serial communication logic.
- Programs related to data transfer between internal and external memory.
- Simulator based programming.
- Some programs should be run on kit and some on simulator.

Term work shall consist of Four experiments.

Text Books/References

- M.A.Mazidi, "The 8051 Micro Controller & Embedded Systems"
- "Intel micro controller data book"
- K.J.Ayala, "The 8051 Micro Controller Architecture, Programming and Applications"
- "Fundamentals of Microprocessors and Microcomputers", B. Ram edition 1995

Syllabus for Unit Test

Unit Test 1	Unit I & II
Unit Test 2	Unit III & IV
Unit Test 3	Unit V & VI

K40504: POWER SYSTEM MODELLING

TEACHING SCHEME	EXAMINATION SCHEME	
Lectures : 04 Hrs/week	Theory	: 70 Marks
Practicals : 02 Hrs/week	Duration	: 03 Hours
	Unit Test	: 30 Marks
	T.W.	: 25 Marks
	Oral	: 25 Marks

Unit -I (08 Hours)

Modelling of Power System Components:

The need for modelling of power system, different areas of power system analysis, Simplified models of non- electrical components like boiler, steam & hydro- turbine & governor system. Transformer modelling such as auto-transformer, tap- changing & phase- shifting transformer.

Unit –II (08 Hours)

Synchronous Machine Modelling:

Model required for steady-state analysis, The development of model required for dynamic studies, The current & flux linkage models using Park's transformation leading to simulation as linear model.

Unit-III (08 Hours)

Analysis of Synchronous Machine Modelling:

Synchronous machine connected to an infinite bus, its simulation for steady- state condition.

Unit-IV (08 Hours)

Excitation System Modelling – I:

Simplified view of excitation control, Excitation configuration, primitive systems, Definitions of voltage response ratio & exciter voltage ratings.

Unit-V (08 Hours)

Excitation System Modelling – II:

Excitation control systems using dc generator exciter, alternator- rectifier, alternator- SCR, voltage regulators such as electro- mechanical and solid state.

Unit-VI (08 Hours)

Transmission Line, SVC and Load Modelling:

Transmission lines, d-q transformation using alpha and beeta variables, static VAR compensators, load modeling.

List of Practical

- Modelling of Nonelectrical components of power system.
- Modelling of Electrical components of power system.
- Modelling of excitation control systems using electromechanical or solid state voltage regulators.
- Analysis and modelling of static VAR compensators.

Four experiments may be conducted using Matlab/Etap

Text Books/References

- "Power System Control and Stability", Vol.–I, Anderson 7 Foud, IEEE Press, New York
- Olle Elgerd, "Electrical Energy System Theory – An Introduction" TMH Publishing Company, 2nd Edition, New Delhi
- John J. Granier and W. D. Stevenson Jr, "Power System Analysis" 4th Edition, McGraw Hill International student edition
- K. R. Padiyar, "Power Systems Dynamics", B. S. Publications
- Kundur, "Power System Dynamics & Control", IEEE Press, New York
- P. S. R. Murthy, "Power System Operation & Control"

Syllabus for Unit Test

Unit Test 1	Unit I & II
Unit Test 2	Unit III & IV
Unit Test 3	Unit V & VI

SEMESTER - II

K40505: POWER SYSTEM DYNAMICS

TEACHING SCHEME
Lectures : 04 Hrs/week

EXAMINATION SCHEME
Theory : 70 Marks
Duration : 03 Hours
Unit Test : 30 Marks

Unit -I (08 Hours)

Review of Classical Methods of Power System Dynamic Studies:

States of operation and system security, system stability, system model-classical model of system of one machine connected to infinite bus, Clark diagram for two machines series reactance system, extension of Clark diagram to cover any reactance network, elementary model of overall power system, multimachine model, simple representation of excitation control.

Unit –II (08 Hours)

Dynamics of Synchronous Generator Connected to Infinite Bus:

System model, simplified synchronous machine model, calculation of initial conditions, system simulation, improved model of synchronous machine, inclusion of SVC model.

Unit-III (08 Hours)

Analysis of Single Machine:

Small signal analysis, application of Routh- Hurwitz criterion, analysis of synchronizing & damping torque, state equation for small signal model.

Unit-IV (08 Hours)

Power System Stabilizers:

Basic concepts of control signals in power system stabilizers (PSS), structure and tuning, field implementation, PSS design and application, future trends.

Unit-V (08 Hours)

Multi-machine system:

Simplified model, improved model of the system for linear load, inclusion of load and SVC, introduction to analysis of large power system.

Unit-VI (08 Hours)

Voltage stability:

Definition, factors affecting voltage stability & collapse, analysis & comparison of angle & voltage stability and voltage instability & collapse, control of voltage instability, islanding-necessity , methods, advantages and disadvantages, implication on power system dynamic performance.

Text Books/ References

- Anderson & Foud, "Power system Control & Stability", IEEE press, New York
- Olle Elgerd, "Electrical Energy System Theory - An Introduction", TMH
- K R Padiyar, "Power System Dynamics", B S Publications
- Prabha Kundur, "Power system Stability & control", TMH
- C.W.Taylor, "Power System Voltage Stability", TMH
- R. A. Walling, " Distributed Generation Islanding", N.W. Miller
- Hadi Saadat, "Power System Analysis", MGH International

Syllabus for Unit Test

Unit Test 1	Unit I & II
Unit Test 2	Unit III & IV
Unit Test 3	Unit V & VI

K40506: ADVANCED PROTECTIVE RELAYING

TEACHING SCHEME		EXAMINATION SCHEME	
Lectures	: 04 Hrs/week	Theory	: 70 Marks
Practicals	: 02 Hrs/week	Duration	: 03 Hours
		Unit Test	: 30 Marks
		T.W.	: 25 Marks
		Oral	: 25 Marks

Unit -I (08 Hours)

General Principles:

Philosophy of protection scheme, Protective relay, Digital Protection of power system, fault analysis, basic requirements, principles, classification and components of static relays, static over current relays, directional over current relay, under frequency relays, static differential relay.

Unit –II (08 Hours)

Comparators:

General mathematical theory of relay as comparator, phase and magnitude comparators, analysis of dual input comparators, relay characteristics, static distance relay (reactance, impedance, and mho), reach, multi input comparators, pilot relaying scheme.

Unit-III (08 Hours)

Protection of Transmission Line:

Protective scheme, Distance relays, setting, synthesizing relay characteristics, effect of power swing, three stepped distance scheme, digital protection based on fundamental signal, introduction of digital protection of EHV / UHV transmission line, protective schemes based on traveling waves, new relaying scheme using amplitude comparison

Protection of Bus Bar.

High impedance differential scheme, modern bus bar protection.

Unit-IV (08 Hours)

Protection of Synchronous Generator:

Faults in synchronous generator, protection schemes for synchronous generator, digital protection of synchronous generator.

Unit -V (08 Hours)

Protective Instrument Transformers:

Modeling and standards of CTs & PTs, simulation of transients, flux swing, capacitor type voltage transformers (CVTs), mixing transformer.

Protection of Power Transformer

Faults in a transformer, schemes used for transformer protection, digital protection of transformer.

Unit –VI (08 Hours)

Digital Computer Application Protection:

Use of computer in network automation & power system protection, calibration & setting of relays using computers.

List of Practicals

- Study of Static/Microcontroller based over current relay.
- Study of Static/Microcontroller based Differential relay.
- Study of Static/Microcontroller based Distance relay.
- Study of Static/Microcontroller based underfrequency relay.

Term work shall consist of Four experiments.

Text Books/ References

- L. P. Singh, "Digital Protection: Protective Relaying from Electromechanical to Microprocessor", Publications: New Age International (P) Ltd.
- A. J. Johns and S. K. Salman, "Digital Protection for Power System", Peter Pereguines for IEE
- Dr Paithankar, "Transmission Network Protection-Theory and Practice", Marcel Dekker, Inc.
- A. G. Phadke and J. S. Thorp, "Computer Relaying for Power Systems", John Wiley and sons
- J. L. Blackkburn, "Protective Relaying (Principles and applications)", Marcel Dekker, Inc.
- T. S. Madhav Rao, "Power System Protection-Static Relays", Tata McGraw Hill

Syllabus for Unit Test

Unit Test 1	Unit I & II
Unit Test 2	Unit III & IV
Unit Test 3	Unit V & VI

K40507: POWER SYSTEM AUTOMATION AND CONTROL

TEACHING SCHEME	EXAMINATION SCHEME	
Lectures : 04 Hrs/week	Theory	: 70 Marks
Practicals : 02 Hrs/week	Duration	: 03 Hours
	Unit Test	: 30 Marks
	T.W.	: 25 Marks
	Oral	: 25 Marks

Unit -I (08 Hours)

Automatic Generation Control:

Introduction, The Single Area System, Modelling of the Multi Area System, Generator Excitation Control,The Automatic load frequency control, Automatic Voltage Control, Analysis of system using ETAP Software.

Unit –II (08 Hours)

Power System Automation:

Need of Automation, SCADA Systems, Power System Management Functionalities, Enterprise wide Integration of SCADA for Power system Automation, Mapping of various functions, Power System. Case studies using PSCAD/EMTDC Software.

Unit-III (08 Hours)

Integrated Information Systems:

Schematic of Integrated Information Systems, IT Architecture, Hardware Architecture, Software Architecture, Energy Management System (EMS), System Analysis using, standard Power system software.

Unit-IV (08 Hours)

Communication Protocols:

Communication Protocols for Power System Automation, New structure in Deregulated Environment, Various Communication Protocols, The OSI 7 layer Model, The Functionality of different layers, Distributed Network Protocol (DNP).

Unit -V (08 Hours)

Standards for Power System Automation:

Emergence of Standard, DNP 3 Protocol, DNP 3.0 Structure, Structure of IEC 60870 - 5,DNP 3.0 and IEC 60870,5101, IEC 60870,5 Series, IEC - 61850,61107,IEC 62056 Series, IEC 62056 Series,IEC TCS57 Reference Architecture, Relevant IEC Standards

Unit –VI (08 Hours)

The Future of Automated Power System:

Changes in the Past, Changes in the Future, Security, Meeting of Productivity, Web Applications, Marketability, Reliability of Automated Power Systems Engineering Achievements with Automated Power Systems.

List of Practicals

- Case study on distribution system automation
- Analysis of integrated information system
- Case study on Energy Management System
- Case study on system architecture and IEC standard
- Case study on SCADA for power system automation and control.

Term work shall consist of four experiments using power system softwares

Text Books/ References

- A. K. Mahalanbis, D. P. Khothari, "Computer Aided Power System Analysis and Control", S. I. Ahson (Tata McGraw Hill)
- J. Arrillaga, "Computer Modelling of Electrical Power Systems", N.R. Watson 2ND Edition, WSE Willey Publications
- Padiyar K.R ., "Power system Dynamics: Stability and Control"
- Miller Robert H., "Power System Operation"
- S. C. Siacca, W. R. Block, "Advanced SCADA Concept"
- George L. Kusic, "Computer Aided Power System Analysis", Prentice Hall India

- R.N.Dhar, "Computer Aided Power System Operation and Analysis", Tata McGraw Hill, New Delhi
- M.A.Pai, "Computer Techniques in Power System Analysis", Tata-McGraw Hill, New Delhi
- Stagg and EI. Abiad, "Computer Methods in Power System Analysis", McGraw Hill –Japan Edn.
- Peter W. Sauer, M.A.Pai, "Power System Dynamics and Stability", LPE- Pearson Education Press

Syllabus for Unit Test

Unit Test 1	Unit I & II
Unit Test 2	Unit III & IV
Unit Test 3	Unit V & VI

K40508: POWER SYSTEM PLANNING AND RELIABILITY

TEACHING SCHEME
Lectures : 04 Hrs/week

EXAMINATION SCHEME
Theory : 70 Marks
Duration : 03 Hours
Unit Test : 30 Marks

Unit -I (08 Hours)

Load forecasting:

Introduction, Factors affecting load forecasting, load growth characteristics, classification of load and its characteristics, load forecasting methods- i)Extrapolation ii) Co-relation Techniques , Energy forecasting , peak load forecasting, reactive load forecasting, Non-weather sensitive forecasting, weather sensitive forecasting, Annual, Monthly, Total forecasting.

Unit –II (08 Hours)

System Planning:

Introduction, Objectives and factors affecting to system planning, short term, Medium term, long term Planning, various methods of system planning.

Unit-III (08 Hours)

Reliability :

Reliability, Failure, Concepts of Probability, Evaluation techniques i) Markov Process ii) Recursive Techniques, Stochastic Prediction of Frequency and duration of long & short Interruption, Adequacy of reliability, Reliability Cost.

Unit-IV (08 Hours)

Generation Planning and Reliability:

Objectives and factors affecting generation planning ,Generation Sources , Generation System Model , Loss of Load (calculation and Approaches), Outage rate , Capacity Expansion Scheduled outage , Loss of energy , evaluation methods.

Inter connected system, Factors affecting interconnection under emergency assistance.

Unit -V (08 Hours)

Transmission Planning and Reliability:

Introduction, Objectives of Transmission Planning, Network Reconfiguration, System and Load Point Indices, Data required for Composite System Reliability.

Unit –VI (08 Hours)

Distribution Planning and Reliability:

Redial Networks – Introduction, Network Reconfiguration, Evaluation Techniques, Interruption Indices, Effects of Lateral Distribution Protection, Effects of Disconnects, Effects of Protection Failure, Effects of Transferring Loads, Distribution Reliability Induces. Parallel & Meshed Networks – Introduction, Basic Evaluation Techniques, Bus bar Failure, Scheduled Maintenance, Temporary and Transient Failure, Weather Effects, Breaker Failure.

Text Books/ References

- X Wang & J.R. McDonald, "Modern Power System Planning", McGraw Hill Book. Company
- R L. Sullivan, "Power System Planning ", Tata McGraw Hill Publishing Company Ltd.
- T Gonen "Electrical Power Distribution Engineering", McGraw Hill Book Company
- Roy Billinton & Ronald N Altan, "Reliability Evaluation of Power System", Springer Publication
- A.S. Pabla, "Electrical Power Distribution", Tata McGrav Hill Publisting Company Ltd.
- B R Gupta, "Generation of Electrical Energy", S. Chand Publications
- T W Beme, "Electricity Economics & Planning", Peter Peregrinus Ltd., London

Syllabus for Unit Test

Unit Test 1	Unit I & II
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SEMESTER - III

K40509 ELECTIVE I: ARTIFICIAL INTELLIGENCE & ITS APPLICATIONS IN POWER SYSTEM

TEACHING SCHEME
Lectures : 04 Hrs/week

EXAMINATION SCHEME
Theory : 70 Marks
Duration : 03 Hours
Unit Test : 30 Marks

Unit-I (08 Hours)

Introduction to Artificial Intelligence:

Introduction, Fuzzy systems, Artificial Neural Network (ANN), Expert Systems, Genetic Algorithm, Evolutionary Programming.

Biological neurons: Function of single biological neuron, function of artificial neuron, Basic terminology related to artificial neuron.

Characteristics of ANN, Typical applications of ANN such as classification, pattern recognition, forecasting Properties, strength of NN.

Unit-II (08 Hours)

Different Architectures of ANN and Learning Processes:

Different architectures of Neural Network, types of activation function, concept of Learning with a Teacher, Learning without a Teacher, Learning Tasks (Any two learning methods and applications)

Unit-III (08 Hours)

Single Layer Network and Multi-layer Network:

Single Layer Perceptron: architecture – training algorithm, Least – Mean square algorithm, learning curves, Learning Rate, Annealing techniques.

Feed forward Neural Network (MLP), Back propagation algorithm. Limitation of Back-propagation algorithm. Concept of learning rate, momentum coefficient, Generalization capacity.

Unit-IV (08 Hours)

Fuzzy Mathematics:

Basic concept of Fuzzy Logic, Fuzzy set – Basic definition – Membership function, Operations of fuzzy sets.

Unit-V (08 Hours)

Fuzzy Theory:

Fuzzy relations - Fuzzy graphs - Fuzzy analysis – Propositional logic , predictive logic, Fuzzy set theory.

Unit-VI (08 Hours)

Applications in Power Systems:

Application of ANN and Fuzzy logic in Power System Planning, Operation and control – load forecasting, Unit Commitment, Load Dispatch and Protection.

Text Books/ References

- Simon Haykin, "Neural Networks: A Comprehensive Foundation", 2nd Edition, Pearson Education
- Mohamed H. Hassoun, "Fundamentals of Artificial Neural Network", Practice Hall India
- Jacek Zurada, "Introduction to Artificial Neural Network", Jaico Publishing House India
- James A. Anderson, "An Introduction to Neural Networks", Practice Hall India Publication
- Zimmermann, H. J., "Fuzzy Set Theory and Its Applications", 2nd Edition, Kluwer Academic Publishers
- A. J. Wood and B. F. Wollenberg, "Power Generation, Operation and Control", New York: Wiley, 1996
- H. Li, P. Chen, and H. Huang, "Fuzzy Neural Intelligence Systems", Boca Raton, FL: CRC, 2001.
- El Hawaray, "Electrical Power Applications with Fuzzy systems", IEEE Press
- D. P. Kothari, J. S. Dhillon,"Power System Optimisation", PHI
- John Yen, Reza Langari, "Fuzzy Logic-Intelligence,control and Information" Pearson Education
- M. Ganesh, "Introduction to Fuzzy Sets and Fuzzy Logic" Prentice Hall India

- Kelvin Waruicke, Arthur Ekwlle, Raj Agarwal, "AI Techniques in Power System", IEE London U. K.
- S. Rajsekaram, G. A. Vijayalaxmi Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms Synthesis & Applications", Practice Hall India
- S. N. Sivanandam, S. Sumathi, S. N. Deepa, "Introduction to Neural Network Using MATLAB 6.0", Tata McGraw Hill
- George Klir & Tina. A. Folger, "Fuzzy Sets, Uncertainty and Information", Prentice Hall of India Pvt. Ltd
- G. F. Luger and W. A. Stubblefield, "Artificial Intelligence Redwood City", CA: Benjamin Cummings, 1993
- Eugene Charniat, Drew McDermott, "Introduction to Artificial Intelligence", Pearson Education

Syllabus for Unit Test

Unit Test 1	Unit I & II
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K40509 ELECTIVE I:
ELECTRICAL POWER QUALITY ISSUES

TEACHING SCHEME
Lectures : 04 Hrs/week

EXAMINATION SCHEME
Theory : 70 Marks
Duration : 03 Hours
Unit Test : 30 Marks

Unit-I (08 Hours)

Introduction:

Importance of power quality, terms and definitions of power quality as per IEEE std. 1159. Such as transients, short and long duration voltage variations, interruptions, short and long voltage fluctuations, imbalance, flickers and transients. Voltage Swells, Long Duration over Voltages, under voltages, Voltage unbalance, Voltage Fluctuations, Harmonics, Electrical Noise.

Sources of Power Quality Problems, Effects of Power Quality problems.

Unit-II (08 Hours)

Voltage sag, swells and interruptions:

Sources of sag and interruptions, Estimation of voltage sag performance, Fundamental principles of protection, solutions at end user level, utility systems and fault clearing issues, motor starting sags, evaluation of the economics of different alternatives.

Unit-III (08 Hours)

Transient Over- Voltages:

Sources of transient over voltages – capacitor switching, lightening, Ferro resonances and other switching transients. Principles of over voltage protections, devices of over voltage protections. Utility capacitor – switching transients. Utility system lightening protection, managing Ferro resonance, switching transients problems with loads, computer tools for transient analysis.

Unit-IV (08 Hours)

Harmonics:

Definition of harmonics, interharmonics, subharmonics. Causes and effect

of harmonics. Voltage versus current distortion. Overview of fourier analysis. Harmonic indices. A.C. quantities under non-sinusoidal conditions. Triplen harmonics, characteristics and non characteristics harmonics. Harmonics series and parallel resonances. Consequences of harmonic resonance. Principles for controlling harmonics. Reducing harmonic currents in loads. K-rated transformer. Harmonic study procedure. Computer tools for harmonic analysis. Locating sources of harmonics. Harmonic filtering, passive and active filters. Modifying the system frequency response. IEEE Harmonic standard 519-1992.

Unit-V (08 Hours)

Power quality monitoring:

Need of power quality monitoring and approaches followed in power quality monitoring. Power quality monitoring objectives and requirements. Initial site survey. Power quality Instrumentation. Selection of power quality monitors, selection of monitoring location and period. System wide and discrete power quality monitoring. Setting thresholds on monitors, data collection and analysis. Selection of transducers. Harmonic monitoring , Transient monitoring, event recording and flicker monitoring.

Unit-VI (08 Hours)

Power Quality Assessment & Mitigation:

Power Quality assessment, Power quality indices and standards for assessment disturbances, waveform distortion, voltage and current unbalances. Power assessment under waveform distortion conditions. Power quality state estimation, State variable model, observability analysis, capabilities of harmonic state estimation. Test systems. Mitigation techniques at different environments.

Text Books/References

- "Understanding Power Quality Problems, Voltage Sag and Interruptions", M. H. J. Bollen IEEE press, 2000, series on power engineering.
- Pogei C. Dugan, Mark F. McGranghan, Surya santoso, H. Wayne Beaty, "Electrical Power System Quality", second edition, McGraw Hill Pub.
- J. Arrillaga, M. R. Watson, S. Chan, "Power system quality assessment", John Wiley

and sons.

- G. J. Heydt, "Electric Power Quality"
- Enriques Acha, Manuel Madrigal, "Power System Harmonics: Computer Modeling and Analysis", John wiley and Sons Ltd.
- J. Arrillaga & N. Watson, "Power System Harmonics"
- "IEEE std 519-1992/ IEEE std 1159 IEEE Recommended Practices and Requirements for Harmonics Control in Electrical Power System"

Syllabus for Unit Test

Unit Test 1	Unit I & II
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K40509 ELECTIVE I:
ADVANCED POWER ELECTRONICS

TEACHING SCHEME
Lectures : 04 Hrs/week

EXAMINATION SCHEME
Theory : 70 Marks
Duration : 03 Hours
Unit Test : 30 Marks

Unit -I (08 Hours)

Review of Modern Power Devices:

Constructional features, characteristics and specifications of following power devices-SCR, GTO, MOSFET, IGBT, MCT. Comparison of devices.

Unit –II (08 Hours)

Voltage Source Converters:

3-ph- full wave bridge converter, operation and harmonics, Transformer connection for 12 pulse operation, 24 and 48 pulse operation. Operation of 12-pulse converter. 3 level voltage source converter. PWM converter. Generalised technique of harmonic elimination and voltage control. Advanced modulation techniques (SPWM, space vector modulation, 3rd harmonic PWM) Comparison of PWM techniques. Converter rating.

Unit-III (08 Hours)

Self and Line commutated current source converter:

Basic concepts of CSC, converters with self commutating devices. Comparison with voltage source converter.

Unit-IV (08 Hours)

Multilevel Inverters:

Multilevel concept, Types of multilevel Inverters, diode clamped multilevel inverter, flying-capacitors multilevel inverters, cascaded multilevel inverter, applications switching device currents, d.c. link capacitor voltage balancing, features of multilevel inverters, comparison of multilevel converters.

Unit-V (08 Hours)

Energy Storage Systems:

Flywheel energy storage system, superconducting magnetic energy storage system, other energy storage systems, active filters, shunt, series and hybrid filters.

Unit-VI (08 Hours)

Akagi's p-q theory:

Conventional concepts of active and reactive power in single phase and three phase circuits- Equation of power with sinusoidal voltage source and non-linear loads- transformation of three phase four wire system- Akagi's instantaneous power (pq) theory- relationship between Akagi's components and conventional active and reactive power application of pq theory to reactive and harmonic power compensation in simple circuits

Active filters- series, shunt, and their comparison.

Text Books/ References

- E. Acha, Miller & Others, "Power Electronic Control in Electrical Systems", Newnes, Oxford publication - first Edition
- M. H. Rashid, "Power Electronics", Prentice Hall of India Pvt. Ltd.
- N. G. Hingorani & L. Gyugyi, "Understanding FACTS", IEEE Press, Indian Edition
- E. H. Watanube, R. M. Stephen and Maurico Ardes, "New Concepts of Instantaneous Active and Reactive Powers in Electrical systems with Generic loads", IEEE transaction on Power Delivery Vol.8, no.2 April 1993, PP-697-703
- L. Benchaita, S. Sadaate and A. Salemnia, "A Comparison of Voltage Source and Current Source Shunt Active Filter by Simulation and Experimentation", IEEE Transaction on Power Systems , Vol 14, No.2, May 99, PP 642-647

Syllabus for Unit Test

Unit Test 1	Unit I & II
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K40509 ELECTIVE I:
STATIC DEVICES IN POWER SYSTEMS

TEACHING SCHEME
Lectures : 04 Hrs/week

EXAMINATION SCHEME
Theory : 70 Marks
Duration : 03 Hours
Unit Test : 30 Marks

Unit -I (08 Hours)

Power Electronic Controllers:

Basics, challenges and needs, static power converter structures, AC controller based structures, D.C. link converter topologies, converter output and harmonic control, power converter control issues.

Unit –II (08 Hours)

Shunt Compensation:

SVC and STATCOM: Operation and control of SVC, STATCOM configuration, control & applications.

Unit-III (08 Hours)

Series Compensation:

Principle of operation, application of TCSC for damping of electromechanical oscillations, application of TCSC for mitigation of sub-synchronous resonance, TCSC layout and protection, static synchronous series compensator (SSSC).

Unit-IV (08 Hours)

Unified Power Flow Controller:

Steady state operation, control and characteristics, introduction to transient performance, power flow studies in UPFC embedded systems, Operational constraints on UPFC.

Unit-V (08 Hours)

Other FACTS Controllers:

Circuit, model and operating features of Dynamic Voltage

Regulator(DVR), Thyristor Controlled Braking Resistors (TCBR), Thyristor Controlled Phase Angle Regulator(TCPAR), comparison of all FACTS controllers.

Unit-VI (08 Hours)

Control Strategies and co-ordination:

Conventional control, Hysterisis control, Artificial Neural Network, fuzzy logic controls, comparison between different control schemes, co-ordination between different FACTS controllers.

Text Books/ References

- E. Acha, Agelidis, Anaya-Lara, Miller, "Power Electronic Control in Electrical Systems", Newnes Power Engg. Series, London, International Student Edition
- Hingorani and Gyugui, "Understanding FACTS", IEEE Press, New York, Indian Edition
- Yong Hua Song and Johns, "Flexible A. C. Transmission Systems (FACTS)", IEE Power and Energy Series 30
- Verma, Mathur, "Thyristor based FACTS controllers", IEEE Press, New York
- K. R. Padiyar, "Sub-synchronous Resonance", B. S. Publications, Hyderabad

Syllabus for Unit Test

Unit Test 1	Unit I & II
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K40510 ELECTIVE II: RENEWABLE ENERGY SYSTEMS

TEACHING SCHEME
Lectures : 04 Hrs/week

EXAMINATION SCHEME
Theory : 70 Marks
Duration : 03 Hours
Unit Test : 30 Marks

Unit -I (08 Hours)

Energy Scenario:

Classification of Energy Sources, Energy resources (Conventional and non-conventional), Energy needs of India, and energy consumption patterns. World-wide Potentials of these sources. Energy efficiency and energy security. Energy and its environmental impacts. Global environmental concern, Kyoto Protocol, Concept of Clean Development Mechanism (CDM) and Prototype Carbon Funds (PCF). Factors favoring and against renewable energy sources.

Unit –II (08 Hours)

Solar Energy:

Solar thermal Systems: Types of collectors, Collection systems, efficiency calculations, applications.

Photo voltaic (PV) technology: Present status, solar cells , cell technologies, characteristics of PV systems, equivalent circuit, array design , building integrated PV system, its components , sizing and economics. Peak power operation. Standalone and grid interactive systems.

Unit-III (08 Hours)

Wind Energy:

Wind Energy: Wind speed and power relation, power extracted from wind, wind distribution and wind speed predictions.

Wind power systems: System components, suitability of generators, turbine rating, electrical load matching, variable speed operation, maximum power operation, control systems, system design features, stand alone and grid connectivity, impacts of wind farms.

Unit-IV (08 Hours)

Other energy sources:

Biomass – various resources, energy contents, technological advancements, conversion of biomass in other form of energy – solid, liquid and gases. Gasifiers, Biomass fired boilers, Co firing, Municipal solid waste systems, Problems in harnessing these sources.

Hydro energy – feasibility of small, mini and micro hydel plants scheme layout economics.

Tidal and wave energy ,Geothermal and Ocean thermal energy conversion (OTEC) systems – schemes, feasibility and viability.

Unit-V (08 Hours)

Energy storage and hybrid system configurations:

Energy storage: Battery–types, equivalent circuit, performance characteristics, battery design, charging and charge regulators. Battery management. Fly wheel- energy relations, components, benefits over battery. Fuel Cell energy storage systems.

Stand alone systems, Hybrid systems: hybrid with diesel, with fuel cell, solar-wind, wind –hydro systems, mode controller, load sharing, system sizing. Hybrid system economics.

Unit-VI (08 Hours)

Grid Integration:

Grid connected system and their electrical performance: Interface requirements, synchronization with grid, inrush, stable operation, load transient, safety. Operating limits of voltage, frequency, stability margin, energy storage, and load scheduling.

Effect on power quality: harmonic distortion, voltage transients and sags, voltage flickers. Dynamic reactive power support. Systems stiffness. Effect of Utility restructuring.

Text Books/ References

- Mukund Patel, "Wind and solar systems", CRC Press
- Tapan Bhattacharya, "Solar Photovoltaics for Terrestrials"

- Njenkins, "Wind Energy Technology", John Wiley & Sons
- McNeils, Frenkel, Desai, "Solar & Wind energy Technologies", Wiley Eastern
- S. P. Sukhatme, "Solar Energy", Tata McGraw Hill
- S. Bandopadhay, "Solar Energy", Universal Publishing
- "Guide book for National Certification Examination for EM/EA – Book 1"
- R. Ramesh, "Renewable Energy Technologies", Narosa Publication
- S. Rao, "Energy Technology", Parulkar
- Mittal, "Non-conventional Energy Systems", Wheelers Publication

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K40510 ELECTIVE II: ADVANCE MICRO CONTROLLERS AND IT'S APPLICATIONS IN POWER SYSTEM

TEACHING SCHEME
Lectures : 04 Hrs/week

EXAMINATION SCHEME
Theory : 70 Marks
Duration : 03 Hours
Unit Test : 30 Marks

Unit -I (08 Hours)

Introduction to PIC 16F8XX family and development tools. CPU architecture and instruction set. Harvard architecture and pipelining, program memory considerations, register file structure and addressing modes, CPU registers.

Unit –II (08 Hours)

PIC peripherals:

I/O ports, external interrupts and timers, timer operation, ADC, short overview of synchronous serial port, serial peripheral interface I2C bus.

Unit-III (08 Hours)

Learning MPLAB (V 5.0 or above) Integrated development environment from Microchip (Assembler and simulator)

Study of applications like motor control, temperature control, lamp dimmer, 4X4 matrix keyboard and LCD interfacing etc.

Unit-IV (08 Hours)

ARM & AVR Processors:

RISC, ARM design philosophy, ARM fundamentals, instruction set, thumb instruction set, exception & interrupt handling, efficient C programming, optimizing ARM assembly code, AVR architecture, instruction set, hardware interfacing, communication links and design issues

Unit-V (08 Hours)

Interfacing considerations:

Intel process communication, synchronization of processes,tasks, threads,

devices & buses for networks, hardware-software co-design embedded programming in C/RT Linux.

Unit-VI (08 Hours)

Real time operating systems:

Survey of software architectures- round robin, with interrupts, function queue scheduling, RTOS architecture, selecting an architecture, task states, task and data semaphores and shared data, message queues, mailboxes, pipes, timer functions, events, memory management, interrupt routines in an RTOS environment, basic design using RTOS, embedded software development tools, Micro C/OS- II, VX works.

Text Books/ References

- "Microchip PIC Family Microcontroller Handbook"
- John Peatman, "Design with PIC Microcontrollers", Pearson Education Asia, LPE
- Rajkamal, "Embedded System–Architecture, Programming and Design", TMH Publication, edition 2003
- David Simon, "An Embedded Software Primer", Pearson education, Asia
- Jonathan W. Valvano, Brooks, Cole, "Embedded Microcomputer Systems-Real Time Interfacing", Thomson Learning

Syllabus for Unit Test

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K40510 ELECTIVE II: POWER SECTOR ECONOMICS AND RESTRUCTURING

TEACHING SCHEME
Lectures : 04 Hrs/week

EXAMINATION SCHEME
Theory : 70 Marks
Duration : 03 Hours
Unit Test : 30 Marks

Unit -I (08 Hours)

Power Sector in India:

Introduction to various institutions in an Indian Power sector such as CEA, Planning Commissions, PGCIL, PFC, Ministry of Power, state and central governments, REC, utilities and their roles. Critical issues / challenges before the Indian power sector, Salient features of Electricity act 2003, Various national policies and guidelines under this act.

Unit –II (08 Hours)

Power Sector Economics and Regulation:

Typical cost components and cost structure of the power sector, Different methods of comparing investment options, Concept of life cycle cost , annual rate of return , methods of calculations of Internal Rate of Return(IRR) and Net Present Value(NPV) of project, Short term and long term marginal costs, Different financing options for the power sector. Different stakeholders in the power sector, Role of regulation and evolution of regulatory commission in India, types and methods of economic regulation, regulatory process in India.

Unit-III (08 Hours)

Power Tariff:

Different tariff principles (marginal cost, cost to serve, average cost), Consumer tariff structures and considerations, different consumer categories, telescopic tariff, fixed and variable charges, time of day, interruptible tariff, and different tariff based penalties and incentives etc., Subsidy and cross subsidy, life line tariff, Comparison of different tariff structures for different load patterns. Government policies in force from

time to time. Effect of renewable energy and captive power generation on tariff, Latest reforms and amendments.

Unit-IV (08 Hours)

Power Sector Restructuring and Market Reform:

Different industry structures and ownership models.

Competition in the electricity sector- conditions, barriers, different types, benefits and challenges.

Different market and trading models / arrangements, key market entities- ISO, Genco, Transco, Disco, Retailco, Power market types, Energy market, Ancillary service market, transmission market, Forward and real time markets, market power.

Unit-V (08 Hours)

Electricity Markets Pricing and Non-price Issues:

Electricity price basics, Market Clearing price (MCP), Zonal and locational MCPs.

Dynamic, spot pricing and real time pricing, Dispatch based pricing, Power flows and prices. Optimal power flow Spot prices for real and reactive power. Unconstrained real spot prices, constrains and real spot prices.

Non price issues in electricity restructuring (quality of supply and service, environmental and social considerations) Global experience with electricity reforms in different countries.

Unit-VI (08 Hours)

Transmission Planning and Pricing:

Transmission planning, Different methods of transmission pricing, Different transmission services, Congestion issues and management, Transmission cost allocation methods, Locational marginal price, and firm transmission right.

Transmission ownership and control, Transco and ISO, Transmission pricing Model in India, Availability based tariff, role of load dispatch centers (LDCs) Salient features of Electricity act 2003, Price based Unit commitment, concept of arbitrage in Electricity markets, game theory methods in Power System, and security constrained unit commitment.

Ancillary services for restructuring, forward ancillary service auction. Power purchase agreements.

Text Books/References

- "Know Your Power", A citizens Primer On the Electricity Sector, Prayas Energy Group, Pune
- Sally Hunt, "Making Competition Work in Electricity", 2002, John Wiley Inc
- Edward Kahn, "Electric Utility Planning and Regulation", American Council for Energy Efficient Economy
- "Regulation in Infrastructure Services: Progress and The Way Forward - TERI, 2001"
- "Maharashtra Electricity Regulatory Commission Regulations and Orders", www.mercindia.com
- Prayas, "Reports and Presentations", Various publications, Energy Group, Pune, www.prayaspune.org
- "Central Electricity Regulatory Commission, Regulations and Orders", www.cercind.org
- "Electricity Act 2003 and National Policies", www.powermin.nic.in
- Mohammad Shadepur, Hatim Yatim, Zuyi Li, "Market Operations in Electric Power Systems Forecasting, Scheduling and Risk Management"
- Bhanu Bhushan, "ABC of ABT - A primer on Availability Tariff", www.cercind.org

Website

- www.mercindia.com
- www.cercind.org
- www.prayaspune.org

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K40510 ELECTIVE II: NANOTECHNOLOGY

TEACHING SCHEME
Lectures : 04 Hrs/week

EXAMINATION SCHEME
Theory : 70 Marks
Duration : 03 Hours
Unit Test : 30 Marks

Unit -I (08 Hours)

Introduction to Carbon Materials:

Historical introduction, Basic background, Introduction to quantum mechanics-matter waves, Heisenberg uncertainty principle, Schrödinger equation, electron confinement, tunneling of a particle through potential barrier, Structure and bonding of nanomaterials, Special properties of carbon nanotubes.

Unit –II (08 Hours)

Synthesis of Nanomaterials:

Growth mechanism, Arc discharge-synthesis of SWNT and MWNT, Laser ablation-SWNT versus MWNT, large scale synthesis of SWNT, FEL method, continuous wave laser-powder method, Chemical vapour deposition-plasma enhanced chemical vapour deposition, thermal chemical vapour deposition, Flame synthesis, Purification techniques-oxidation, acid treatment, annealing, ultrasonication, magnetic purification, micro filtration, cutting, functionalisation, chromatography.

Unit-III (08 Hours)

Properties of Nanomaterials and Analysis Techniques:

Mechanical properties, Structural properties, Melting of nanoparticals, Electrical Conductivity, Optical properties, Magnetic properties, Introduction to analysis techniques-microscopes, electron microscopes, scanning probe microscopes, diffraction techniques, spectroscopies, magnetic measurements, lithography.

Unit-IV (08 Hours)

Potential Applications of CNTs:

Energy storage-hydrogen storage, lithium intercalation and electrochemical supercapacitors, Molecular electronics-field emitting devices, transistors, Nanoprobes and sensors, Composite materials and Templates. Experimental studies and modeling of energy storage devices.

Unit-V (08 Hours)

Molecular Electronics and Transistors:

Field emitting devices-fabrication of CNT electron field emitters, field emission from CNT films, degradation of CNT films, field emission from single CNTs, Transistors-principles of the MOSFET and CNTFET, manufacturing of a CNTFET, CNTFET physics, switching mechanism of a MOSFET and CNTFET, characterization and optimization of a CNTFET.

Unit-VI (08 Hours)

Some special nanomaterials, applications and societal implications of nanoscience and technology (in developing countries):

Porous silicon, Aerogels, Zeolites, Ordered porous materials using micelles as templates, Self assembled nanomaterials, Core- Shell particles, Applications-Automobiles, Textiles, Cosmetics, Sports , Domestic appliances, Biotechnology and Medical Field, Space and Defense, Issues-An outlook, Nanotechnology and Environment,Nano policies and institutions.

Text Books/References

- T. Pradeep, "Nano: The Essentials", McGraw Hill Education
- Sulabha K. Kulkarni, "Nanotechnology: Principles and Practices", Capital Publishing Company
- M S Dresselhaus, Gene Dresselhaus and Ph. Avouris, "Carbon Nanotubes Synthesis, Structure, Properties and Applications", Springer

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RULES REGARDING ATKT, CONTINUOUS ASSESSMENT AND AWARD OF CLASS

A. T. K. T.

- A candidate who is granted term for M.Tech Semester-I will be allowed to keep term for his/her M.Tech. Semester-II examination even if he/she appears and fails or does not appear at M.Tech. Semester-I examination.
- A candidate who is granted term for M.Tech Semester-III will be allowed to keep term for his/her M.Tech. Semester-IV examination even if he/she appears and fails or does not appear at M.Tech. Semester-III examination.
- A student shall be allowed to keep term for M.Tech Semester-III even if he/she has a backlog of all Heads of passing in theory examination held at M.Tech Semester I & II taken together.
- A student has to secure 40% marks in theory and 50% marks in TW & oral as a condition of pass class. The overall percentage of marks of all semesters taken together should be more than 50% to declare the student to be passed.

CONTINUOUS ASSESSMENT

- The term work assessment will be based on the practical/assignment as described in the syllabus.
- Final assessment of termwork shall be done by pair of internal and external examiners jointly during the oral/practical examination schedule declared by the university. The teacher conducting practicals/assignments during the term shall maintain a record of continuous assessment. Every practical/term work/assignment shall be assessed continuously on the scale of 20 marks and weightage of 20 marks shall be distributed as follows:

Sr. No.	Activity	Marks
1	Timely Submission	04
2	Presentation	06
3	Understanding	10

This record of continuous assessment shall be made available to the examiners during Term work and oral examination. Examiner shall use this record for overall assessment of the performance of the student.

- Assessment of the seminar work and dissertation work shall be done continuously.

• Record of this assessment shall be made available during examination. The student should submit the dissertation stage-I report along with the dissertation stage-II report at the time of final submission.

CLASS

• The class should be awarded to the student on the basis of aggregate marks obtained together in both the semesters of the respective year by him/her. The award of class shall be as follows.

A	Aggregate 66% or more marks	First Class with Distinction
B	Aggregate 60% or more marks but less than 66%	First Class
C	Aggregate 55% or more marks but less than 60%	Higher Second Class
D	Aggregate 50% or more marks but less than 55%	Second Class
E	Aggregate 40% or more marks but less than 50%	Pass Class